The Splashdam Coal Horizon in Virginia: A Natural, and Active and Abandoned Mine, Hazard[1]

Anthony S. Scales[2]

Abstract. The Splashdam Coal Horizon outcrops principally in Buchanan and Dickenson Counties, Virginia, and is a potential geological hazard in its unmined state. Geological characteristics and topographic location make it a prime source of rockfall, landslide and drainage problems. Abandoned Splashdam surface mines are not typically problem areas, as mining removes potential slide material. Abandoned underground mining, however, has great potential to promote slope failure and cause blowouts due to the Splashdam Horizon's hydrologic and geomorphologic setting. Residential expansion has placed many home sites at risk of impact from the Splashdam Horizon, both in mined and unmined settings. The Abandoned Mine Land Program's long history of addressing these problems has served to provide the Regulatory Program with guidelines to assess proposed mining in this seam. Recognition of the geomorphologic and hydrologic setting of the Splashdam Horizon is critical in remediation design and future mine planning.

Additional Key Words: blowout, Buchanan County, Dickenson County, debris avalanche, debris flow, fracture-flow, geohazard, geomorphology, landslide, mud flow, rockfall, slide, Wise County

---

[1]Paper was presented at the 2006 National Association of Abandoned Mine Land Programs 28th Annual Conference, September 25-27, 2006, Billings MT.

[2]Anthony Scott Scales, Mineral Specialist I – Geologist, Virginia Department of Mines, Minerals and Energy, Division of Mined Land Reclamation, P. O. Drawer 900, Big Stone Gap, VA 24219.

Introduction

The Splashdam Coal Seam has been mined in the coalfields of Southwest Virginia since the 1800's, first for "housecoal" and later, in the early 1900's, as a major production source (see Figure 1). Since inception of the regulatory and abandoned mine land programs in Virginia, the Splashdam Horizon, i.e., the seam and enclosing strata, has been recognized for its potential to cause both active and abandoned mine problems, and even to pose a geo-hazard in its undisturbed state. The geologic, topographic and hydrologic settings of this horizon all contribute to these characteristics. This paper details these characteristics and problems, primarily based on empirical observations from the Virginia program.

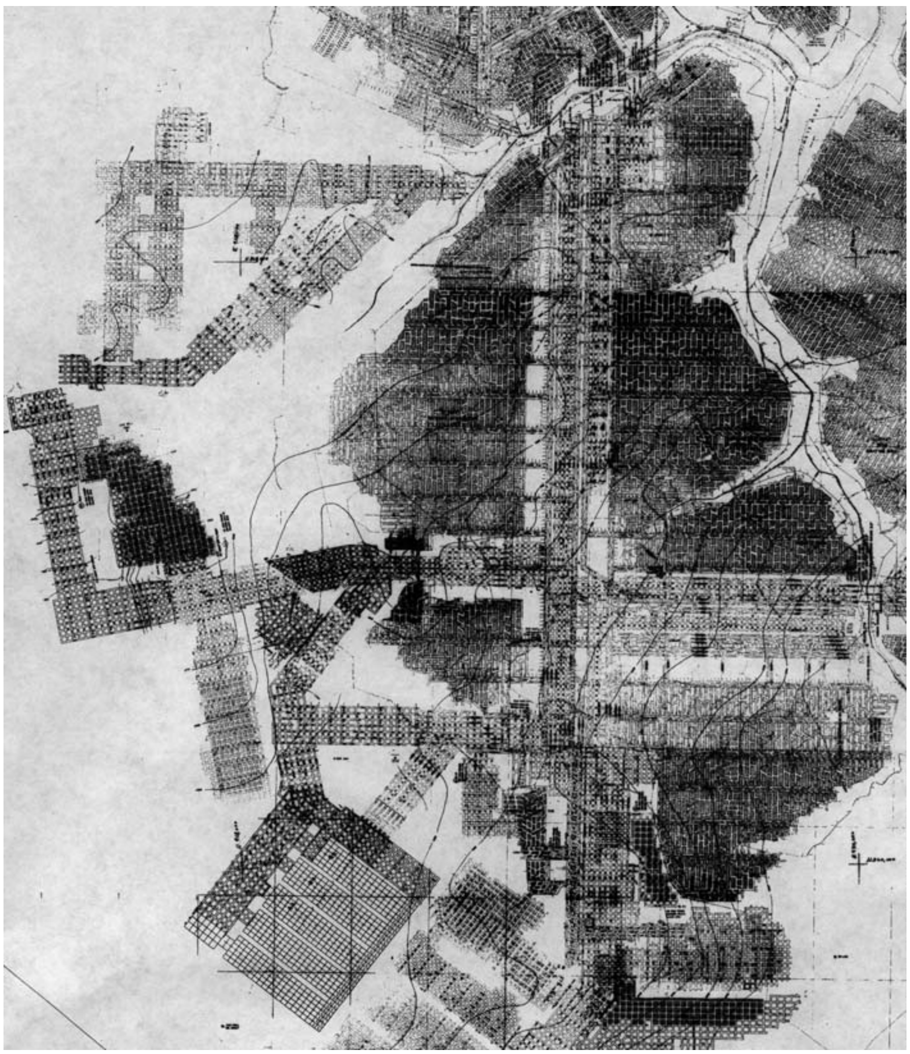

Figure 1. An underground mine map of an area of the Splashdam seam in Buchanan County, Virginia. Those acquainted with such maps will recognize the numerous eras of mining represented by the different pillar designs. Area shown is approximately 7.5 square miles.

What's In a Name?

While recognized by early explorers and geologists as a potentially mineable seam, it was not until December 4, 1909 that the seam we know as the Splashdam gained that name. How do we know this? Unlike many seams, which are named for a place, such as the Clintwood for Clintwood, Virginia, or for inherent characteristics, such as the Low Splint, the Splashdam was named for a thing, and yes, that thing was a splash dam.

In April of 1909, the Yellow Poplar Lumber Company of Coal Grove, Ohio began construction of a splash dam on the Russell Fork, a tributary of the Big Sandy River, in Dickenson County, Virginia to facilitate movement of timber down that river to their sawmill. The obstacle to overcome was the rocky chasm called "The Breaks", sometimes called the deepest gorge east of the Mississippi River. That dam was completed in November of 1909, and the first splash of logs through the gorge occurred on December 4, 1909 (see Figure 2). So, while extant for over 300 million years, the Splashdam has a definite "born on" date. (The nearby community of Splashdam was also named for that dam structure).

The splash dam was built on lands controlled by George L. Carter, the great coal and railroad magnate of Southwest Virginia and Southern West Virginia. His earliest coal companies eventually morphed to one of the first giants in the Southwest Virginia Coalfield, the Clinchfield Coal Company. Giles (1921) stated "The Splash Dam (*note: this was the earliest way to write the name, but has since changed to one word*) bed, so named on maps of the Clinchfield Coal Corporation because it rises from beneath Russell Fork near the splash dam, a short distance north of the mouth of Pound River…" And while he certainly didn't realize it at the time, Mr. Giles hinted at the problem maker this seam would be in later years by making the simple observation, "It lies a few feet above the sandstone directly above the Upper Banner, which is a conspicuous cliff-former along Levisa Fork and elsewhere. The rocks above the coal differ from place to place, being chiefly shale in some localities and coarse sandstone in others."

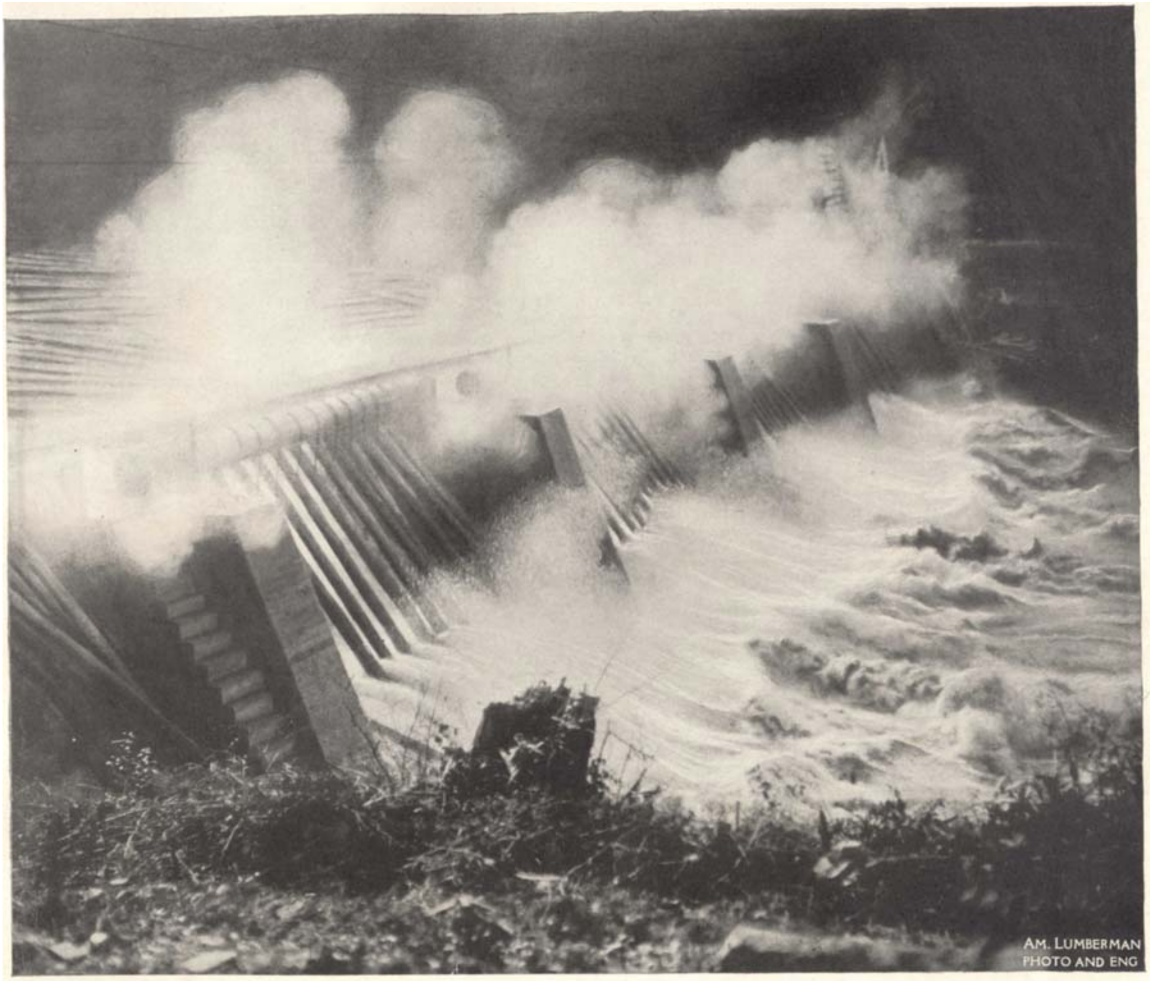

Figure 2. On December 4, 1909, the Yellow Poplar Lumber Company blew the retaining spars on the company's splash dam on the Russell Fork River, Dickenson County, Virginia, and provided a name for a coal seam.

Geologic Setting of the Splashdam Coal Seam

The Splashdam occurs at the near midpoint of the Norton Formation of Middle Pennsylvanian Age (see Figure 3). Based on floral zone characterization, the Splashdam formed between 316-317 million years ago.

The Splashdam Horizon, as noted by Giles previously, typically overlies a thick (average 75 feet, up to 130 feet) cliff and ledge forming sandstone, which in turn overlies the Lower Banner coal bed (see Figure 4). The immediate floor rock can be either shale or this sandstone (see Figure 5). The Splashdam can occur in up to 4 splits separated by highly variable thicknesses of shale and sandstone, but for purposes of this paper we are concerned with those areas where the splits coalesce to form a single underground-mineable seam, or a split is thick enough to be recovered by underground mining. Overlying the Splashdam is a sandstone, identical to the one below seam, or a shale (see Figure 6). This interval averages 100 feet, but can be up to 130 feet to the next higher seam, the Hagy.

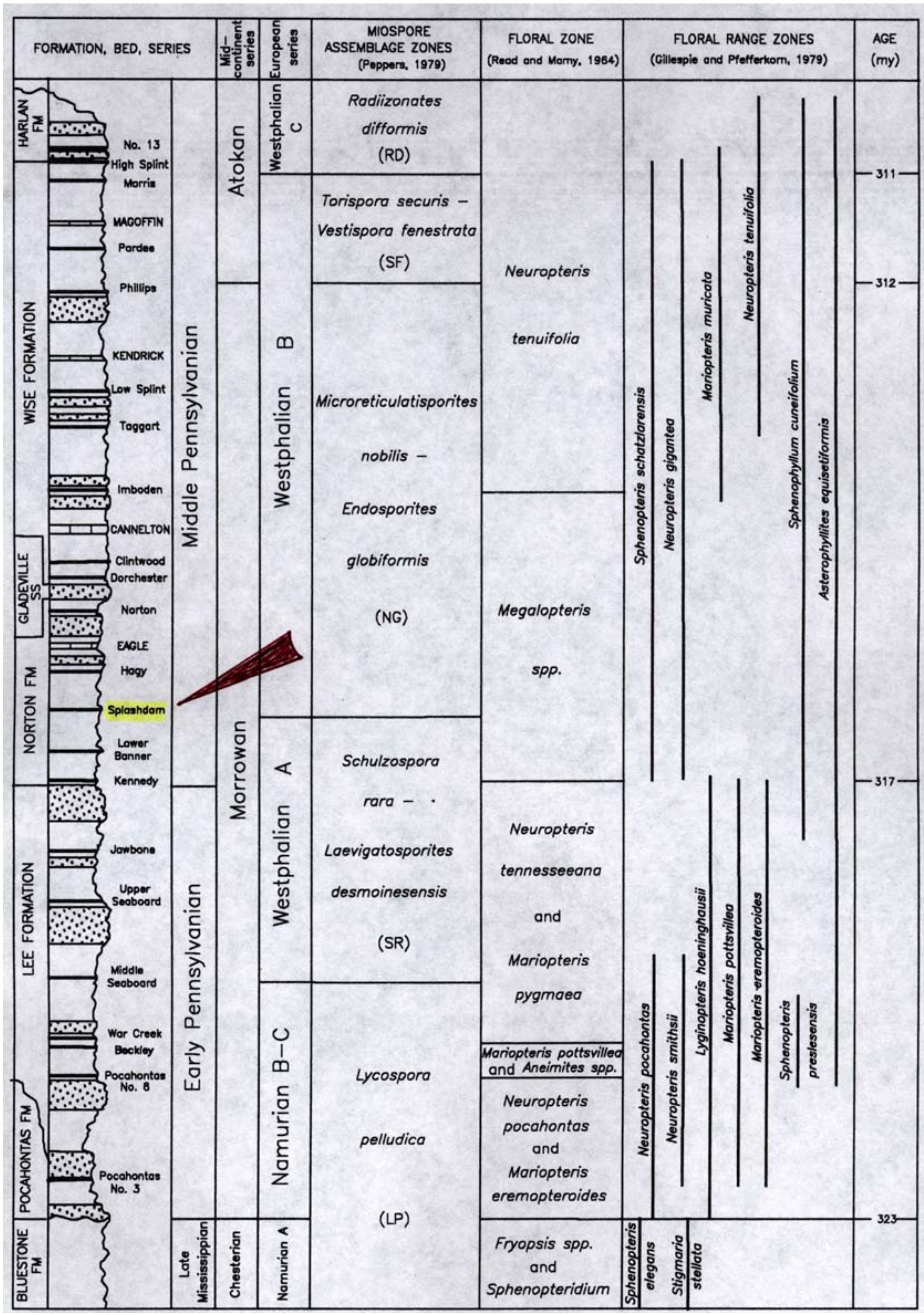

Figure 3. Position of the Splashdam seam relative to other seams in the Virginia coalfields and age as determined from floral zones. From Nolde (1994).

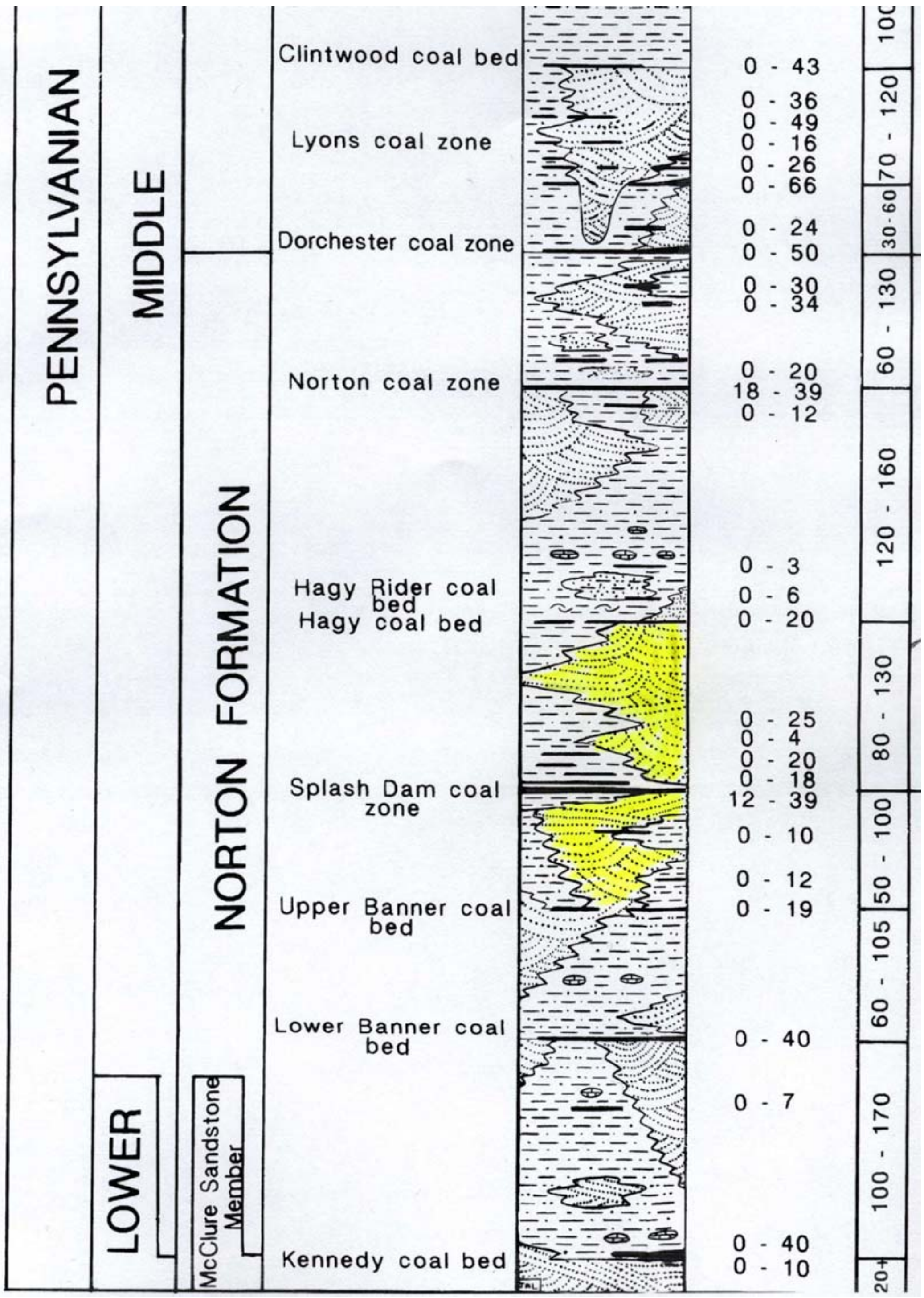

Figure 4. Stratigraphic column for the Splashdam coal zone. From Lovett et al., (1994).

Figure 5. Splashdam seam in highwall, here underlain by shale. Photograph by Gary Shifflett. Buchanan County, Virginia.

Figure 6. Underground mine face-up with the massive sandstone typically overlying the Splashdam seam. Photograph by Gary Shifflett. Buchanan County, Virginia.

No formal research has been done on the paleodepositional setting of the Splashdam. Given the occurrence of a marine fossil zone in some localities 10 to 20 feet above the Splashdam seam, and that this zone is often truncated by channel-form sandstone bodies, it appears most likely the Splashdam formed in a middle-delta plain setting, proximal to, but relatively protected, from marine inundation, in back-swamp areas between river channels. This is supported by analyses of discharges from abandoned underground mines, almost all of good quality with few acid mine drainage problems. The Splashdam is a typical banded, medium- to high-volatile A bituminous coal. On a raw coal basis, it averages greater than 13,500 BTU/lb, and greater than 15,000 BTU/lb on a clean coal basis, making its preference as a production horizon obvious.

Topographic, Geomorphologic and Hydrologic Setting of the Splashdam Coal Seam

Due to geologic structure and the happenstances of erosion, within the Southwest Virginia Coalfield the Splashdam typically outcrops just above valley bottom, to about midway of valley slopes (see Figure 7). Outcrops are solely within the drainages of Russell Fork and tributaries in Dickenson and Wise counties, and Levisa Fork and Knox Creek and their tributaries in Buchanan County. Buchanan, Wise and Dickenson Counties are the three greatest coal-producing counties, respectively, of the seven in Southwest Virginia.

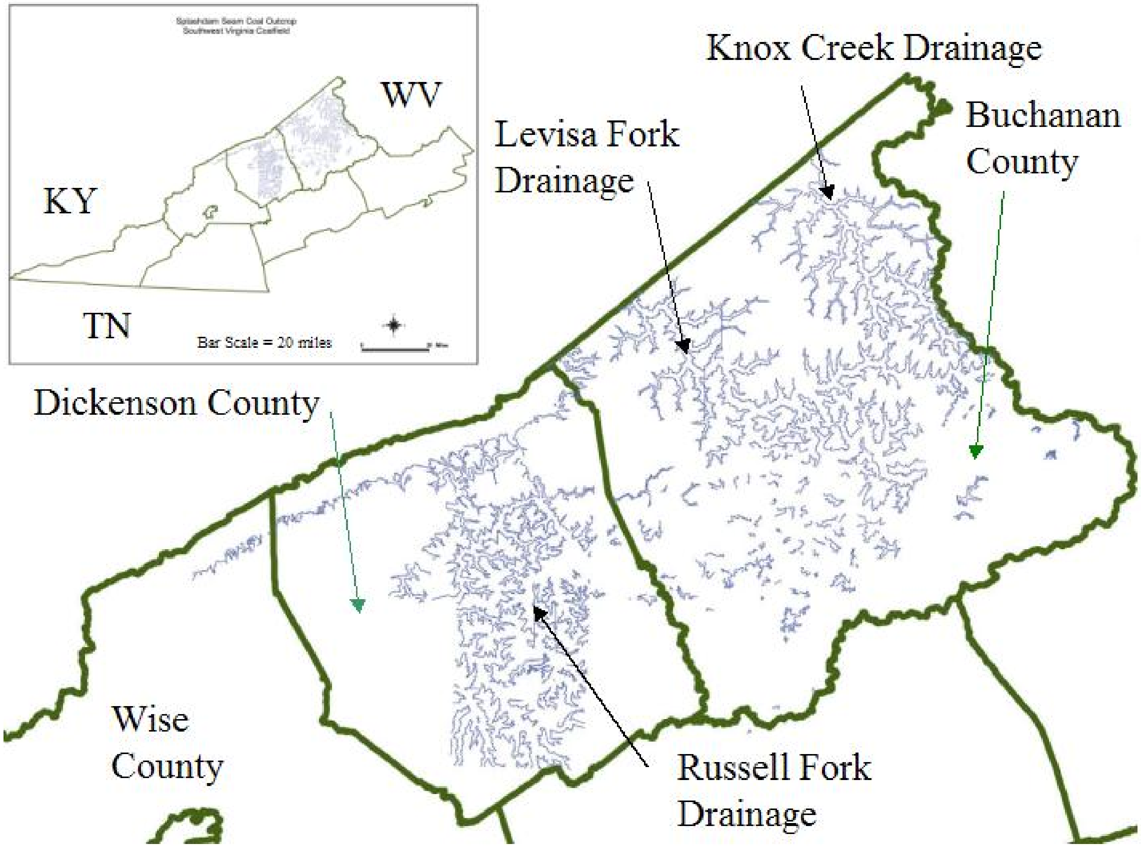

Figure 7. Outcrop of the Splashdam coal seam in the Southwest Virginia Coalfield.

In natural (undisturbed) setting, the Splashdam is rarely exposed, but its position can often be estimated by the top of the underlying, ledge-forming sandstone (see Figure 8). Often the seam is covered by sandstone cobbles/boulders, or a sandy-clayey colluvium from the overlying sandstone, and often the colluvium from these two sandstones coalesce to form a cobble slope and/or cobble apron ringing the valley walls (see Figures 9 and 10). In hollows, whether shallow or deep, cragdingles, as defined by Outerbridge (1987), may form. These are upland hollows where sandstone cobbles, often in this sandy-clayey matrix, collect by toppling or eroding from the cliff-forming sandstone. Such deposits are sources for debris flows and landslides.

Figure 8. Sandstone cliff at the Splashdam Horizon. Photograph by Gary Shifflett. Buchanan County, Virginia.

Figure 9. Cobble and boulder apron below sandstone cliff seen in previous figure. Photograph by Gary Shifflett. Buchanan County, Virginia.

Figure 10. A typical cobble slope at the Splashdam Horizon. The arrow points to a landslide headscarp with approximately 1 foot of vertical displacement. Buchanan County, Virginia.

As the Splashdam outcrops in the lower half of valley slopes, it is in that position defined by Wyrick and Borchers (1981) and Harlow and LeCain (1991) where the valley slope is transitional from a compressional to tensional regime. Thus, it is in a prime location to be, and certainly is, a water-producing zone. Water moving through stress release fractures enters the Splashdam, which then acts as an aquifer, water traveling through the cleats, and exiting as contact or colluvial springs. Many households, from earliest settler to present homebuilder, have been served by a Splashdam spring.

The Splashdam Horizon as a Natural Hazard

While it is more proper to define the hazard potential of the Splashdam seam in terms of its encapsulating rocks, and the weathering products of the seam and those rocks. i.e. the "horizon," the Splashdam itself plays a key role due to its transmissivity. The weathered encapsulating shales and sandstones, whether in the form of a colluvial apron, cobble slope or cragdingle, are often in a constantly lubricated state where the Splashdam discharges water. These slopes are often at near-angle of repose, 30 degrees or higher (see Figure 10). Scales (1995) noted that, during high precipitation events, excess water, whether from upslope runoff or from the seam itself, can mobilize the weathered colluvium, causing slumps, debris avalanches, debris flows and landslides (see Figures 11, 12 and 13).

Figure 10. A view of a Splashdam Horizon slope, illustrating steepness. Note the curved tree trunks indicating the slope is continually creeping. Viewpoint is the same as following figure. Photograph by Gary Shifflett. Buchanan County, Virginia.

Figure 11. Looking downslope from same viewpoint as previous figure. Splashdam colluvium failed during a high precipitation event, causing the debris and mud flow visible. Photograph by Gary Shifflett. Buchanan County, Virginia.

Figures 12 and 13. Newer home sites in the Southwest Virginia Coalfield, if not on mountaintop, are built along valley bottoms. Where below the Splashdam Horizon, situations such as this may occur. Debris and mudflow is from area shown in previous two figures. No abandoned or active mining was involved in its formation. Photographs by Gary Shifflett. Buchanan County, Virginia.

Where the Splashdam seam exists in a cliff or ledge setting, rockfall potential is high (see Figures 14 and 15). Rockfalls may be initiated by any event, from high precipitation to long-term weathering. (Note: All surface mines are required to have in place a ground control plan to prevent such occurrences, but is of special concern at the Splashdam Horizon).

Figures 14 and 15. Left photograph shows the source cliff for the boulder seen in right photograph. No abandoned or active mining was involved in this occurrence. Cliff is 600 horizontal feet away from, and 200 vertical feet above, the residence. Two smaller boulders entered the home; no one was injured. Buchanan County, Virginia.

As with any geo-hazard, its potential to cause harm or damage must be gauged by man's interaction, or potential to interact, with it. In the 18th and 19th centuries, home site construction in the coalfield area occurred along valley bottom or on ridgetops, i.e., the top of the plateau. Early settlers picked choice spots, and obviously did not choose to build on unstable ground or below ledges and cliffs. However, beginning in the 20th century and continuing to present, with choice sites occupied and coalfield population increasing, new home sites and other construction have expanded into these less desirable, if not downright dangerous areas, including the midslope of valleys where the Splashdam occurs (see Figures 16 and 17).

Figures 16 and 17. A poorly sited house; excavation did not encounter bedrock and undercut the already unstable Splashdam colluvial slope. The ground crept for years, finally slumping during high-intensity rainfall. No mining was associated with this occurrence. Buchanan County, Virginia.

The Splashdam Horizon in Abandoned and Active Mine Settings

Where surface mined, slope failure due to disturbance of unstable slopes associated with the Splashdam is usually not a consideration, whether new mining or abandoned. In most cases, contour or area mining completely removes the slide- and rockfall-prone material, and can actually lessen risk of failure. Two caveats exist: A) if the abandoned site was mined by the "shoot and shove" method, i.e., material deposited downslope, either from the Splashdam to lower elevations, or from higher elevations onto Splashdam Horizon colluvium, slope stability may be exacerbated, and; B) in both active and abandoned scenarios, the propensity of drainage from the seam itself may cause, or contribute to, slope instability (see Figures 18, 19 and 20), and, of course, drainage control must be considered (see Figure 21). (Note: Attempt was made to quantify the number of slope failure investigations conducted by the VA DMME since inception of the regulatory program, and what percentage involved the Splashdam Horizon, but due to numerous factors, particularly a huge number of reports, many uncategorized, an absolute value could not be determined. However, this author was able determined that, out of 25 slide/rockfall reports where he was principal investigator, 6, or nearly 25%, were related to the Splashdam. Other investigators report a similar, if not greater, percentage.)

Where underground mined, whether in an abandoned or active/planned setting, the likelihood is great, if not certain, that significant underground storage and/or discharges of water will occur. As noted above, this is simply a function of the Splashdam Horizon's hydrologic setting. Where secondary recovery occurs, which is typically the case in all Splashdam underground mining, the Splashdam will be a significant groundwater collection gallery. In all cases, active or abandoned, when not free draining it must be assumed the mine will fill, and blowout and outcrop barrier conditions/protection must be evaluated.

Figures 18 and 19. These photographs show good house seat construction along a valley slope; excavation was into bedrock. Unfortunately, an underground Splashdam mine in the slope above served as a groundwater collection gallery, water bleeding through the outcrop barrier and over the cut slope; the water is highly ferruginous, but not acidic. Buchanan County, Virginia.

Figure 20. Landslide headscarp resulting from a blowout. The top of a Splashdam split is indicated by the arrow; a middleman separates this unmined split from the mined split. Water exited from fractures in the sandstone well above the mined seam, initiating the slide higher than the mine horizon. Buchanan County, Virginia.

Figure 21. Horizontal drilling, shown here, drained the mine that caused the landslide in the previous figure. Water is exiting at the unmined split level; drilling started at the unmined split, penetrated the middleman (horizontal arrow) and entered the mined split (vertical arrow) at depth. Buchanan County, Virginia.

Future Problems With the Splashdam Horizon

Not to appear flippant, but future problems with the Splashdam Horizon will be "more of the same." However, it appears that most will be AML considerations, as the bulk of Splashdam underground reserves in Virginia have been recovered, particularly in the 1930s-1970s (see Figure 22). Current and planned underground mining are simply to recover small blocks within these largely mined-out reserves. Little, if any, further surface mining is anticipated in outcrop areas, particularly as these areas have been underground mined. Regardless, recognition of potential hazards should negate further problems from these mining methods.

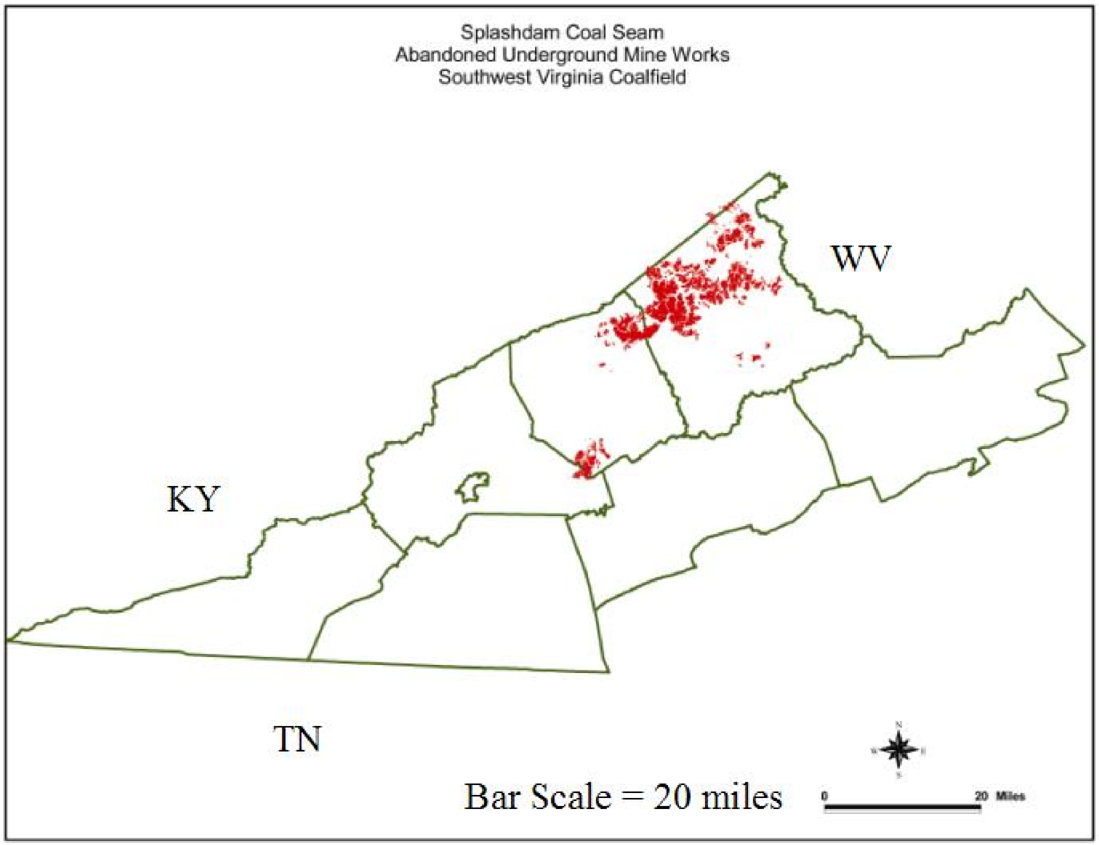

Figure 22. Extent of underground mining in the Splashdam coal seam in the Southwest Virginia Coalfield. Compare to Figure 7.

Acknowledgements

Preparation and presentation of this paper was supported in part by the Office of Surface Mining Reclamation and Enforcement, National Technical Training Program. Of that fine organization, the author is indebted to Division Chief Sarah Donnelly and Technical Training Specialist Jane Stieber, and particularly Technical Training Specialist Ann Walker, who is that rarest of combinations—a colleague and a caring friend. Mineral Specialist-Geologist Leslie Bright and Information Technology Specialist Doug Mullins of the Virginia Department of Mines, Minerals and Energy provided assistance in preparation of some figures, and Reclamation Program Manager Lynn Haynes performed file research. Reclamation Inspector Gary Shifflett, who has probably spent more time on Splashdam slopes than any person living, provided many of the photographs contained here. Information Technology Specialist Janice Scales aided in the formatting of this document and provided moral support for this, and many other, projects. Critical review by Gary Shifflett, Public Information Officer Mike Abbott, Engineer Bob Stimpson and Grants Officer (erstwhile Geologist) Jan Zentmeyer greatly improved this work. The author expresses his gratitude to them, and to many of his fellow co-workers, for their recollection of problems associated with the Splashdam Horizon over the past, nearly 30, years.

Literature Cited

American Lumberman Magazine, March 19, 1910. “Splashing Logs Through Breaks of Sandy.”

Giles, Albert W. 1921. The Geology and Coal Resources of Dickenson County, Virginia. Virginia Geological Survey Bulletin No. XXI.

Harlow, George E., Jr. and LeCain, Gary D. 1991. Hydraulic Characteristic of, and Ground-Water Flow in, Coal-Bearing Rocks of Southwestern Virginia. U. S. Geologic Survey Open-File Report 91-250.

Lovett, J.A., Whitlock, W. W., Henika, W. S. and Diffenbach, R. N. 1992. Geology of the Virginia Portion of the Hurley, Panther, Wharncliffe and Majestic Quadrangles. Virginia Division of Mineral Resources Publication 121.

Nolde, Jack E. 1994. “Devonian to Pennsylvanian Stratigraphy and Coal Beds of the Appalachian Plateaus Province.” In Geology and Mineral Resources of the Southwest Virginia Coalfield. Virginia Division of Mineral Resource Publication 131.

Outerbridge, William F. 1987. The Logan Plateau, a Young Physiographic Region in West Virginia, Kentucky, Virginia, and Tennessee. U. S. Geologic Survey Bulletin 1620.

Scales, Anthony S. 1995. Fracture-Flow Groundwater, Coal Mining and Landslide Development. The Professional Geologist, vol. 32, n. 8.

Wyrick, G. G. and Borchers, J. W. 1981. Hydrologic Effect of Stress-Relief Fracturing in an Appalachian Valley. U. S. Geologic Survey Water-Supply Paper 2177.